PREPARED BY: MANITOBA ENERGY & MINES

ENERGY MANAGEMENT COURSE FOR BUILDING MANAGERS

MG-11881

9 (80-16)
APRIL 1984

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MANITOBA/CANADA CONSERVATION AND RENEWABLE ENERGY DEMONSTRATION AGREEMENT

The availability of secure and affordable energy supplies is a subject of national concern. It is an accepted fact that our primary energy sources - oil and natural gas - are becoming less accessible and more costly. However, Canada is well-endowed with non-renewable and alternative resources that can provide a bridge into the future.

To this end, the governments of Manitoba and Canada have entered into a Conservation and Renewable Energy Demonstration Agreement which was signed May 9, 1980 and terminates March 31, 1984. The Agreement is dedicated to the development and demonstration of conservation and renewable energy technologies. Equally cost-shared by the provincial and federal governments, the program has a total budget of $18-million.

The objectives of CREDA are:

- To develop and demonstrate promising new technologies, which, when widely adopted, will exploit renewable resources, conserve energy and/or use energy more efficiently.
- To develop broad public awareness of the potential of renewable energy and conservation technology.
- To provide opportunities for the commercial application of the technologies within Manitoba.
- To create economic spin-off benefits for manufacturing, industry and commerce.
- To create employment in new or existing energy-related industries.

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1.0 EXECUTIVE SUMMARY

The training of building managers/operators to become energy conscious can be one of the most cost effective ways of saving energy and money. To this end a pilot course in energy management was developed by a task force composed of members from various Government agencies. Funding for this demonstration was made available under CREDA, the Conservation and Renewable Energy Demonstration Agreement. The project cost totalled $5,982, which was cost-shared by the Governments of Manitoba and Canada.

The pilot course was offered in two terms at Red River Community College in Winnipeg. Total length of instruction was 110 hours with lectures scheduled for two afternoons a week. The course covered a number of subjects concerned with energy conservation in building operations and systems design. Twelve operators of Government buildings were enrolled.

Course progress was monitored by an Ad Hoc Committee. An attempt to judge the effectiveness of course training was made by comparing energy consumption in two of the Government buildings before and after the operators had participated in the course. Significant savings of energy and money were reported, however, the actual portions attributable to course training could not be reasonably estimated.

A direct result of the pilot course was the offering, by Red River Community College, of a similar course to the public in 1982/83.

Several poblems were common to both the pilot and public presentations. Chief among these was an over-emphasis of background material on principles of building operation, which resulted in superficial treatment of energy management concepts. The problem has been attributed to the course designs which were aimed at handling a diversity of operator backgrounds, and to the use of inappropriate instructors.

Lack of definition of course goals contributed to attitude problems with some of the course participants and was a result of inadequate communication between the operators and their supervisors.

While the merit of the concept was demonstrated (participants reported increased awareness of energy conservation), overall the course was judged to be unsuccessful in meeting the potential for such instruction. Most operators did not acquire the skills required to properly implement energy management in their buildings.

A number of recommendations for improvement of the course are made in the report.

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1.0 SOMMAIRE

La sensibilisation des responsables de la gestion et des responsables du fonctionnement des immeubles à la conservation de l'énergie peut être l'un des moyens les plus efficaces d'économiser énergie et dollars. Cette démonstration a été financée dans le cadre du programme CREDA, l'Entente Canada-Manitoba de démonstration des économies d'énergie et des énergies renouvelables. Les gouvernements du Manitoba et du Canada ont partagé en part égale les 5 982 $ que représente le coût total de ce projet.

Ce cours-pilote de 110 heures en tout s'est donné pendant deux semestres au collège communautaire de la rivière Rouge, à Winnipeg, à raison de deux après-midi par semaine. Le cours couvrait un certain nombre de sujets sur la conservation de l'énergie et des éléments de base des opérations relatives aux immeubles et de la conception de systèmes. Douze responsables du fonctionnement des immeubles s'étaient inscrits à ce cours.

Un comité ad hoc a été chargé de vérifier les progrès réalisés. On a tenté d'évaluer l'efficacité du cours en comparant l'énergie consommée dans deux immeubles gouvernementaux avant et après le cours. On a constaté des économies appréciables d'énergie et d'argent, mais il n'a pas été possible de déterminer avec précision dans quelle mesure cela pouvait être imputé au cours.

Ce cours-pilote a eu pour conséquence directe la mise sur pied, par le collège communautaire de la rivière Rouge, d'un cours similaire destiné au grand public, cours qui a été offert en 1982-1983.

Le cours-pilote et le cours destiné au public comportaient plusieurs problèmes communs. Le plus important d'entre eux a été l'accentuation trop prononcée des éléments de base, ce qui s'est traduit par une étude superficielle des concepts de la gestion énergétique. On a attribué ce problème d'une part à la composition du cours qui s'adressait surtout à des responsables du fonctionnement des immeubles et d'autre part au manque de qualifications des instructeurs.

Les objectifs mal définis du cours ont également produit un effet négatif sur les participants et ont entraîné un manque de communications adéquates entre les responsables du fonctionnement des immeubles et leurs chefs.

Même si les mérites du projet ont été démontrés (les participants ont mieux compris ce qu'était la conservation énergétique), dans l'ensemble, le cours n'était pas à la hauteur des objectifs visés. La plupart des concierges n'ont pas acquis les connaissances nécessaires pour mettre sur pied un bon programme de gestion de programmes énergétiques dans leurs immeubles.

Le rapport contient un certain nombre de recommandations pour améliorer le cours.

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2. Introduction

It has been estimated that buildings consume, on average, at least 20% more energy than is necessary. Since commercial facilities account for approximately 20% of the total energy consumed in Manitoba, conservation of this waste energy represents a significant saving of finite resources. In addition, fuel price escalations have made energy conservation a consequential means of strengthening corporate positions by reducing financial budgets.

While appropriate technology exists for reduction of excess consumption, implementation of this technology has been superficial. Analysis of this situation has revealed that a lack of training of building managers/operators in the use of this technology is a major factor inhibiting implementation. Conservation of energy in the operation of buildings is contingent largely on the knowledge, attitude and dedication of the operating personnel. Thus, the training of building manager/operators in proven energy conservation techniques is a most important and economic energy conservation initiative.

3. Background

A Provincial task force was formed to develop a pilot building operator training course, which had the working title of "Energy Management Course for Building Managers". ("Energy Management Course for Building Operators" was an interchangeable alternative title). The task force was composed of representatives from the Manitoba Department of Government Services (DGS), Department of Education (Community College Branch), Manitoba Hydro, the Manitoba Telephone System and the City of Winnipeg.

The major task force objective was to suggest a comprehensive energy management training program that would serve as a basis for instruction of the pilot course. The purpose of the pilot course was to monitor and evaluate comprehension levels of students and training time schedules, in order to further develop course content and training procedures.

The course was to have flexibility to accommodate varying complexities and sizes of building systems, and to accommodate the different levels of academic background and experience of the operators. The anticipated result of the pilot program was that the information obtained would be used to design and offer certificate courses in energy management to the public, at community colleges in Manitoba and in other areas of Canada. It was also anticipated that special day courses and seminars could be developed from the pilot program, for training operating personnel who would be unable to attend regular courses.

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Red River Community College, (RRCC) of Winnipeg, received funding under the Manitoba/Canada Conservation and Renewable Energy Demonstration Agreement (CREDA) to subsidize the costs of instruction and the construction of demonstration equipment for the pilot course.

The course was monitored and evaluated by the Provincial Departments of Government Services and Energy and Mines.

4. Pilot Course Details

The task force recommended a series of specific training modules, organized into related blocks, to be used as the basis for the course. Subjects included blueprint reading, principles of various heating, refrigeration and ventilation systems, calibration of controls, demand economics, meter reading and systems maintenance. More detailed descriptions of specific subjects and their organization are provided in Appendix A.

The pilot course, as presented, was significantly changed from the task force's block scheme. The modified first term course outline is listed in Appendix B. Some of the subjects suggested by the task force were dropped and the sequence of instruction was rearranged. The modifications reflect the input of Red River Community College staff, who adapted the task force recommendations to their instructional resources.

The RRCC course was designed to be presented over two successive 10 week terms, 50 hours each, in the fall of 1980 and spring of 1981. However, a suitable instructor could not be found for the spring term and this term was postponed to the fall of 1981. In the interim an instructor was found, and the second term outline was further modified (see Appendix B).

An original task force suggestion was that subject material be structured in levels of complexity so that individual operators could be channelled according to their background and their particular responsibilities in their current positions. The pilot course followed this suggestion to an extent. The first term presented backgrounding in units and principles and overviews of mechanical systems. The second term involved more detail on equipment operation and control (see Appendix B course outlines). There was some overlapping of material due to the change of instructors, and the need to compensate for the extended period between terms.

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The decision was made to restrict the pilot training to operators of government buildings, to allow a closer monitoring of the results. The consideration of saving other building owners the expense of participating in an unoptimized experimental program also affected this decision. To test the flexibility of the instruction programme, an attempt was made to choose operators with various levels of training. Twelve building operators from various government agencies were enrolled in the course. All except one finished both terms. The exception left his position during the interim between terms.

The first term format allowed two periods per week; the first period was typically a two hour lecture on theory and the second a three hour lab emphasizing "hands on" practical experience. The second term format was two three hour periods per week for a term total of 60 hours. All instruction was given in the afternoon, during working hours.

The first term lectures were supplemented with handout notes and reference books. However, specific textbooks were not initially recommended. In the second term the Southern Alberta Institute of Technology (SAIT) Correspondence Course text "Heating and Air Conditioning for Building Operators" was recommended as the pilot text [1]. Copies were made available by the Department of Government Services.

Demonstration metering panels and air handling equipment were designed for the course (photographs, Appendix D). However, these were only completed by the second term and saw limited use. Each term of the course was taught by a single instructor with plans for occasional introduction of guest expert speakers. Scheduling also allowed for field trips for "case study" of conventional and energy conserving systems. A general test was given on the first term material. The frequency of testing was increased in the second term.

5. Pilot Course Review

The conduct of the pilot course was periodically reviewed by an ad-hoc committee composed of members from the Department of Government Services, Department of Energy and Mines, Manitoba Hydro, Manitoba Telephone System and Red River Community College.

The main function of the review committee was to emphasize the problems encountered in the programme and to suggest possible solutions. Accordingly, the main findings of the committee will be discussed with this emphasis in following sections.

Generally, the program failed because of a lack of planning and a lack of communication between involved parties. In particular, insufficient advance time was allowed for developing the task force recommendations into an operational format. It should be noted, however, that despite any problems encountered during the pilot course, the participants' overall opinion was that it was useful and should continue in some form.

5.1. Course Justification

The first significant problem arose as a result of poor communication between the course organizers and the participating operators, regarding definition of the course goals. This was the fault of management, and was largely unavoidable at the time, because scheduling to fit RRCC timetables required that students be enrolled on short notice. The virtual conscription required to meet the quota exacerbated the situation.

In a majority of cases, the immediate supervisors of DGS personnel enrolled in the pilot program were not made aware of the course content and were not required to take interest in the course. As a result, the intent of the training, and management's expectations, were not transmitted to the course participants.

Participants were especially concerned as to possible effects the course would have on their career movement. Speculation on these concerns involved such matters as duration of the training (some saw the course as a possible start to an ongoing retraining program, unwanted by some), and management's use of course results (pessimistic operators wondered about poor course performance being used against them). While the optimistic operators considered that course attendance could enhance their position, they were concerned that recognition for course completion would not be given.

The consensus of operators was also that the course had not been justified to them in terms of its basic concepts. They were vague as to what "energy conservation" was and to the relative importance of conserving fuel compared to saving money, or for that matter the absolute importance of energy conservation in buildings.

Operators also came with the opinion that much of any useful knowledge they might gain by the course would not be applied, because higher management controlled the decision making and generally would not consider their proposals.

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The review committee found that as the course progressed, many of these concerns diminished. The instructors reported that student outlook improved and that the general consensus was that the concept of the course was good.

The review committee recommended that steps could and should be taken to avoid future labour/management misunderstandings about the course. Suggested solutions were:

a) Involve all management, including administrators at decision making levels, in the course as a first priority. Management must take the course seriously and indicate their acceptance, particularly, by considering operator suggestions for conservation measures.

   Education of management could take the form of a seminar or presentation by the course organizers to the hierarchy of operator supervisors. All department heads and direct supervisors should certainly be made aware of course objectives. They should track the progress of the course and they should offer encouragement to participating operators.

b) Operators should be given a clear definition of program goals, including management expectations, before enrolling in the course. Much of the same information used to inform management on the course could be used, only here it should be presented by management.

5.2. Operator Background

The task force foresaw problems with tailoring instruction to groups of operators with widely varying backgrounds.

There is no standard level of certification for building operators. For example, in large operations, such as governments, building operators may be promoted to their positions through various routes that have different training backgrounds. In many large operations, building operators are not required to know the operation of their sub-systems in detail. This is particularly true in unionized operations where various groups are responsible for the actual adjustment and maintenance of specific building systems. On the other hand, for example, in smaller and/or non-unionized operations, the building operator, by training and responsibility, may know his systems in detail.

The course review committee found that the diversity in background was only a minor problem in terms of presentation of material. A positive aspect to the diversity, the interchange of ideas and experience between operators, was noted by the instructor. With one exception, all operators completed the course with reasonable marks, indicating that the majority could assimilate the course material as taught.

While diversity did not appear to be a major problem in the pilot course, the review committee continued to recognize that it could be a problem in future courses, and considered the matter of achieving greater homogeneity in classes. However, no recommendation was reached.

5.3. Curriculum

The curriculum of instruction was related to the above problems since the course was designed into levels (Term 1 and Term 2) to handle diversity of background. There were a number of complaints about the curriculum.

a) The review committee was informed that the course attempted to cover too much information in the time allotted. A recommendation was put forward that the first term material (background and overviews) be reduced to allow for expansion of the second term material. The committee also discussed the possibility of providing different curricula, to suit various levels of training, and agreed that more than two levels of instruction may be required. This issue was not resolved into a recommendation.

b) A major concern in light of the title and goals of the course, was that the second term did not sufficiently emphasize energy conservation. The committee recommended revision of the course to include greater emphasis on energy conservation. Differentiation between saving energy and saving money is important. Cost-efficient means of energy conservation should be emphasized.

5.4. Time Scheduling

There was some dissatisfaction on the part of both the operators and their management with the scheduling of two afternoons a week over 20 weeks. Consideration was given to recommending that the course be presented in two two-week blocks separated by time back on the job, but this was overruled by a consensus of reviewers in favour of maintaining the original or a similar scheme. The participating operators

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suggested that the two afternoon periods be combined into one full day per week. A final recommendation was that the two three-hour periods be reduced to one four-hour period, which yields a course length of 80 hours over the twenty weeks. Adjustments would have to be made in the curriculum to allow for the reduction.

The extended time between terms one and two resulting from the lack of instructors, altered the course continuity and affected performance in the second term.

5.5. Course Instruction

A single instructor cannot be expected to provide an in-depth course in energy management, particularly when there are few means for the instructor to obtain this training. While lecturing by guest experts was considered prior to and during the pilot course, this action was not realized before the end of the course.

The review committee suggested that in the future, team teaching be attempted by a number of instructors with specific expertise (i.e. plumbing, heating, electrical, insulation, refrigeration, air conditioning, etc.). Expert guest lecturers from outside of the college of instruction should also be scheduled.

Some problems were encountered in providing appropriate instructional aids. The course organizers did not recommend a suitable text for energy management. As previously discussed, the SAIT correspondence course text [1] was used in the second term. However, it should be noted that this book does not stress energy conservation. The "Ener$ave Series",[2] published by Energy Mines and Resources Canada would be a useful supplement. It is important that a suitable reference library be set up at the place of instruction and that texts be assigned.

The demonstration metering and air handling displays were not functional until the second term. It is important that such "hands on" equipment be available when covering areas such as control systems and meter reading.

There was varying opinion on the value of field trips for instructional purposes. Several of the buildings run by operators in the course were visited. This gave the particular operator a chance to review his building, but proved redundant over the length of the course.

The committee recommended that field trips be de-emphasized and the extra time be devoted to principles. It should be noted that the instructor thought the tours worthy, especially in contributing to information exchange. (Perhaps a single tour to a building operated in an energy efficient manner would be of greater instructional value.)

5.6. Class Size

Some discussion of appropriate class size was made. The pilot size, 12, was found suitable by the instructor(s) as it allowed for adequate attention to be given to each student. However, some concerns were expressed about the economics of running small classes and the potentially large demand for this type of course. The review committee recommended that a class size of 16 would be optimum for meeting all of these concerns.

5.7. Assignments and Examinations

Course organizers initially considered that it would not be advisable to request that students take examinations, as it would deter many from enrolling in the course. This did not prove out in practice, however. Course participants in fact suggested that assignments and/or tests should be given for each segment of instruction and that examinations should be mandatory. Examination is particularly important if this were to become a certificate course.

5.8. Recognition of Training

Participants received minimal recognition for their efforts in the program. Red River Community College acknowledged attendance with a card indicating that this was a non-credit course. Of greater significance to the participants, their senior management provided no recognition of their training, not even aknowledgement of their attendance at the course. Participants were greatly disappointed by this.

In review, it was recommended that appropriate recognition be given to course participants by the instructional institution and by the employers, both as an incentive and a reward for completing the course. A certificate or diploma would be appropriate, and would indicate to employers that instruction has been successfully completed.

6. Pilot Course Results

6.1. Reduction of Energy Consumption in Government Buildings.

In an attempt to gauge the effectiveness of the pilot course in meeting the objective of reducing energy consumption, two provincial government buildings, operated by course participants, were monitored. The Department of Government Services compared the energy consumed for the months of June, 1979 (before the course) and June 1982 (after the course) for the Woodsworth Building and the Agricultural Services Complex (A.S.C.) University of Manitoba, both in Winnipeg. The results are presented in Table 1.

Table 1

A Comparison of Historical Consumptions in Two Government Buildings.

	Woodsworth Consumption (MJ/day)	A.S.C. Consumption (MJ/day)	Total Consumption Two Buildings (MJ/day)
June 1979	42,975	15,616	58,591
June 1982	35,749	9,452	45,201
Consumption Reduction (MJ/day)	7,226	6,164	13,390
Reduction %	16.8%	39.4%	22.8%

A comparison of Winnipeg area heating degree days for the two study months shows that June 1982, at 136 Degree Days, exceeded June 1979 at 77 Degree Days. If the June 1982 consumption were normalized to the June 1979 Degree Day level, the total reduction becomes 33,000 MJ/day or 56%. Significant improvements in building operating efficiencies are indicated by these results. The Department of Government Services (DGS) estimated that the actual net total monthly dollar savings between the two months exceeded $2000. It must be emphasized that these numbers should be taken only as an indication of the savings resulting from the course training. Consumption reduction also resulted from actions put forward by higher management and therefore the contribution directly attributable to course training cannot be estimated.

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The results are also very preliminary, and should be averaged over a greater number of buildings and for longer periods of time - at least a full year of operation. Nevertheless, it was the conclusion of a Department of Government Services officer that: "it is the feeling at this Branch that rudimentary to the course of these changes has been the training of the on-site building managers in the technical aspects of their duties. An elevated consciousness of building operating techniques and thereby energy conservation principles, has surely been a favoured consequence of this program."

6.2 Public Course Offering

As a direct result of the pilot course, the Mechanical Engineering Technology Department of Red River Community College offered a public course starting in the fall of 1982. The outline is presented in Appendix C. The course was scheduled for one four-hour period per week, over twenty weeks, for a total of 80 hours. Reference texts were the SAIT Correspondence Course [1] and the Ener$ave Series [2]. Lectures were delivered by a single instructor (who had also presented the second term of the pilot course). Two term tests and a final exam on the course were used for evaluations. In addition, for a term assignment, participants were required to analyze their own buildings and suggest ways of saving energy. Operators received a certificate upon completion of the course. Nine building operators were enrolled in the course, 6 from government agencies and 3 from industry.

7. Evaluation of the Public Course

The Department of Government Services again monitored the course through their participating operators. In addition, the Department of Energy and Mines polled the operators from outside of the government for their opinions.

Apparently the recommendations from the pilot course review were not acted upon, as many of the same problems were encountered in the public course. As a result of their evaluation, DGS reviewers judged the training from this course to be inadequate for their purpose and recommended that their department not support it again in existing form. The industry operators who were polled were not as critical. However, they did agree with a number of the complaints put forward by DGS.

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The main complaint made by all was that the course did not properly emphasize energy management and as a result the major goals of the course were not achieved. DGS reviewers found that their participants graduated with little comprehension of some of the important conservation principles and skills required for energy management.

The lack of emphasis is indicated by the scheduling of subjects as designed and as taught (see course outline, Appendix C). According to the design, energy conservation is not introduced, even in overview, until the ninth week of instruction; the first eight weeks are for backgrounding in building operation principles.

As taught, even less emphasis was placed on conservation. Only the last five of the total of twenty weeks was spent on the principles of energy management and the instructor was forced to rush through most, in an attempt to cover all of the material.

The overemphasis on background may be attributable to a number of factors. Foremost is poor planning carried over from the pilot course.

In conception, the background review was not only intended as a refresher, but also as an equalizer to compensate for the diversity of training backgrounds. In practice, the backgrounding proved ineffective towards both of these purposes. Skilled operators reported that this section was often boring and that it had reduced their enthusiasm for later sections. DGS reviewers found that the emphasis on background was not beneficial to those operators with less training, only more confusing. They found that performance in the course depended largely on the pre-course training and dedication of the operator. Consequently, it was necessary to select the "right type" of operator to suit the course as given.

DGS reviewers considered that the specialization of the instructor, a power engineer, was a factor in the overemphasis on background. Extra time was spent on his specialties. Again, as in the pilot, no team teaching or guest lecturing was scheduled or practiced. In addition, the SAIT text used for the background material, representing a course in heating and air conditioning, does not explicitly cover energy management of these systems.

Course participants also complained of a lack of equipment demonstration. Apparently the display equipment (Appendix D) bought for the pilot course was rarely demonstrated and little "hands on" experience was allowed. Operators also regretted that field trips were not organized for this course.

There were problems again with government employee attitude towards the course. It is assumed that, as with the pilot program, this was a result of poor communication with management, and again, of the short notice conscription of the operators into the course.

The repetition of many of the problems from the pilot course would indicate a lack of follow-up communication between the pilot course organizers and the public course organizers. Some of the public course planners were involved with the pilot course and should have been aware of the review committee recommendations. Unfortunately, insufficient attention was paid to replanning the public course.

Further recommendations for the development of the course were brought forward through discussion with course participants. Some of these were:

a. Remove most of the background material from the course and make it a pre or co-requisite. An understanding of the basic principles of building operation should be assumed and not (re) taught in an energy management course. Removal of this material would allow concentration on energy conservation principles and would allow operators more time to develop the skills to implement these principles.

b. A suggestion for a less severe reorganization of the course would remove only some of the background material to allow more in-depth study of conservation, and start the course with an overview of conservation, with emphasis on course goals.

c. Suggestions were also made towards improving instruction. Participants want "hands-on" demonstration of equipment, as well as field trips to appropriate facilities. The suggestion was made that the college could use their own building systems for demonstration.

   It was recommended that the full time instructor have specialist training in energy conservation to ensure proper emphasis in the course. Specialists could be brought in to cover lectures on specific systems. The operators also wanted to see a greater variety of reference material specializing in energy management.

d. Participants agreed that the term assignment, the preparation of a report on their own building, was an excellent innovation of the public course. The quality of these reports varied roughly according to the background of the operator, but, in all cases the action of completing the assignment caused the operators to at least consider practical applications for conservation in their facilities. If this type of assignment were given as part of an intensive course in energy management, management could expect to receive a useful energy audit, with recommendations for implementation as an immediate result of the course.

8. Conclusions and Recommendations

8.1. An energy management course for building operators is necessary and useful.

8.2. Despite a number of problems with the pilot course, some benefit has been realized. Significant savings were achieved in government buildings operated by course participants, although their direct contribution to total savings cannot be estimated.

8.3. Operators reported an increased awareness of energy conservation. While the merit of this concept has been demonstrated, the full potential of such instruction has not been realized. Operators did not learn as much as they could.

8.4. There were a number of problems with the pilot and the resulting public course. Most notable were:

- Inadequate justification of the course to operators and their supervisors, resulting in attitude and labour-management relations problems.
- Overemphasis on building operations principles background, to the detriment of energy management principles.
- Lack of specialist instruction in energy management principles.
- Lack of, or improper use of teaching aids, particularly "hands-on" demonstrations.

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8.5. A number of recommendations have been made. The major ones are:

- An energy conservation course should be designed to stand alone and is best given at the Community College level. It should commence with a presentation of the basic purpose of energy conservation, then expand to include detailed theoretical and practical training.

- The course should emphasize cost-effective energy management principles, as well as the long range implications of energy conservation.

- A program of this type could be given one full day a week, for a minimum of three months to a maximum of one year.

- Background should be de-emphasized to allow increased emphasis on energy management. Instruction in, or reasonable knowledge of, principles of building and system operation would become a prerequisite. Successful completion of the SAIT Course [1], or a similar program of instruction, would be a suitable prerequisite. Operators with equivalent knowledge, but without this type of certification, could be screened for the course by a pre-test.

- Use specialists in energy management as instructors; failing the availability of a trained specialist an instructor who is at least interested and generally conversant in the overall subject of energy conservation would serve. Supplementation with guest specialists is beneficial and desired, especially in the latter case.

- Provide more practical experience during the course, with hands-on demonstration equipment and appropriate field trips.

- Build and maintain a current reference library and choose texts that emphasize energy management.

- Retain the term assignment, as it obligates the operator to immediately apply concepts learned in the course.

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8.6. Information transfer is a very important element in the preparation of the programme. Goals should be made clear to the operators and their supervisors when first introducing the course to prospective participants.

8.7. In light of the limited success of this program, planners should also consider as guides a number of other, more successful courses in other jurisdictions, such as Britain or the U.S.A. A specific example would be the Building Owners and Managers Institute (BOMI) International training programs.

One approach to course development would be to hire consultants conversant in the field to design a course using input from institutions already providing related courses. These include BOMI, SAIT[1], Ryerson Polytechnical Institute and Mohawk College.

8.8. Governments should support the training of instructors for energy management courses. Initially, because of the lack of accredited programs here, it may be necessary to send trainees to other countries for in-depth training.

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References

1. Correspondence Course, "Heating and Air Conditioning for Building Operators", Southern Alberta Institute of Technology, Calgary, Alberta, 1981.

2. Ener$ave for Industry and Commerce - a series of 10 guides, Numbers E1-77-8 through E1-77-17, published by Energy, Mines and Resources Canada, Office of Energy Conservation, Ottawa, 1977.

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APPENDIX A

TASK FORCE SUGGESTED

SUBJECT BLOCKS

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BLOCK A: MATHEMATICS

BLOCK A - 1

REVIEW OF BASIC ARITHMETIC

GENERAL OBJECTIVE:

To refresh the trainee's skills in performing basic arithmetic operations.

PREREQUISITES:

Nil

SPECIFIC OBJECTIVES:

The trainee will be able to:

1. perform the operations of addition, subtraction, multiplication and division on:
   a) whole numbers
   b) proper and improper fractions
   c) decimal numbers
2. Multiply and divide numbers with positive and negative exponents.
3. Convert between fractions and decimal numbers.
4. Calculate percentages.

EVALUATIVE METHODS:

Evaluation will be based on a written examination.

BLOCK A - 2 SIGNIFICANT FIGURES

GENERAL OBJECTIVE: To develop in the trainee knowledge of the concept and application of significant figures.

PREREQUISITES: A-1

SPECIFIC OBJECTIVES: The trainee will be able to:

1. round off any number to a given number of significant figures or decimal places;
2. perform calculations with large numbers, using the rounding off process to simplify and obtain approximate answers;
3. identify the number of significant figures in:
   a) calculation results
   b) meter readings (dial type).

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK A - 3

SCIENTIFIC NOTATION

GENERAL OBJECTIVE: To develop in the trainee skill in handling large numbers by means of scientific notation.

PREREQUISITES: A - 2

SPECIFIC OBJECTIVES: The trainee will be able to:

1. convert large numbers to powers of ten notation
2. perform multiplication and division of large numbers, using powers of ten notation.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK A - 4

METRIC UNITS AND CONVERSIONS

GENERAL OBJECTIVE: To develop in the trainee skill in the use of S.I. metric units and conversion between SI and non-metric units.

PREREQUISITES: A - 1

SPECIFIC OBJECTIVES: The trainee will be able to:

1. Define the metric units for common measurements used in building management
2. identify the prefixes used in the SI system
3. convert measurements in either SI or non-metric units into the other system.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK A - 5 GRAPHS

GENERAL OBJECTIVE: To develop in the trainee skill in the reading of graphs and in producing graphs from tabulated data.

PREREQUISITES: Nil.

SPECIFIC OBJECTIVES: The trainee will be able to:

1. extract any required information from a range of graphs from simple linear graphs to psychrometric charts
2. prepare a simple linear graph from tabulated bi-variable data

EVALUATIVE METHODS: Evaluation will be based on preparation of graphs - a written examination.

BLOCK A - 6

BASIC ALGEBRA

GENERAL OBJECTIVE: To develop in the trainee skill in manipulating simple algebraic formulae, and solving linear equations in two unkowns.

PREREQUISITES: A - 1

SPECIFIC OBJECTIVES: The trainee will be able to:

1. manipulate simple algebraic formulae (e.g. Ohms Law) to express them in terms of any of the variables
2. solve linear equations in two unknowns to determine the value of one unknown when values of the other are substituted.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

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BLOCK B: COMMUNICATIONS

BLOCK B - 1

EFFECTIVE VERBAL COMMUNICATIONS

TRAINING TIME: Concurrent with other training

GENERAL OBJECTIVE: To develop in the trainee skill in communicating verbally with other persons in a job situation.

PREREQUISITES: General vocabulary equivalent to that of a high school graduate, plus a satisfactory vocabulary of job-related terms.

SPECIFIC OBJECTIVES: The trainee will be able to:

1. speak clearly, enunciating words correctly and using adequate vocabulary
2. speak concisely, and precisely, using correct terminology
3. listen, attentively and with understanding
4. listen, politely and patiently, awaiting an appropriate opportunity to speak or question
5. question, clearly and intelligently, to clarify or obtain further information
6. paraphrase others' descriptive statements.

EVALUATIVE METHODS: Evaluation will be based on participation in verbal presentations with the instructor and other trainees. These presentations may be part of other blocks in the training.

BLOCK B - 2 BLUEPRINT READING

GENERAL OBJECTIVE: To develop in the trainee skill in reading and interpreting construction blueprints which incorporate electrical and HVAC systems.

PREREQUISITES: Knowledge of electrical and HVAC components and systems.

SPECIFIC OBJECTIVES: From a set of construction blueprints, the trainee will be able to:

1. identify electrical system components and locate these in the building to which the blueprints apply
2. trace and describe the distribution of electrical power
3. identify HVAC system components and locate these in the building to which the blueprints apply
4. trace and describe the distribution of water, air and steam
5. identify types of insulation, window construction, and other factors affecting energy gains and losses.

EVALUATIVE METHODS: Evaluation will be based on a practical test of skills involving the trainee's extraction of information from a set of construction blueprints.

BLOCK B - 3

INFORMAL REPORTS

GENERAL OBJECTIVE: To develop in the trainee skills in writing informal reports in the form of memos or letters.

PREREQUISITES: Ability to write acceptable sentences and paragraphs, plus satisfactory general and job-related vocabularies.

SPECIFIC OBJECTIVES: Given an operating problem or other occurrence, the trainee will be able to write a report in which each of the following, as relevant, is clearly identifiable:

1. precise statement of the situation
2. supporting information and data
3. statement of action taken
4. request for materials or information
5. recommendations for further action.

EVALUATIVE METHODS: Evaluation will be based on trainee's reports on hypothetical situations as assigned by the instructor, or actual situations arising during training.

BLOCK C: ENERGY SOURCES

BLOCK C - 1 RENEWABLE AND NON-RENEWABLE RESOURCES

GENERAL OBJECTIVE: To develop in the trainee an understanding of the terms "renewable" and "non-renewable" resources especially pertaining to the Province of Manitoba.

PREREQUISITES: Nil.

SPECIFIC OBJECTIVES: The trainee will be able to:

1. explain the distinction between renewable and non-renewable sources of energy
2. classify common energy sources used in buildings in Manitoba
3. classify alternate energy sources.

EVALUATIVE METHODS: Evaluation will be based on observation by the instructor during class discussion, and/or, on a written examination.

BLOCK C - 2

ECONOMICS AND AVAILABILITY

GENERAL OBJECTIVE:

To develop in the trainee a knowledge of the costs of the various forms of energy available in the Province of Manitoba, as well as some insight into the projected availability of this energy in the next ten years.

PREREQUISITES:

C-1.

SPECIFIC OBJECTIVES:

The trainee will be able to discuss and compare the costs of operating various thermal generation stations versus hydro electrical generation stations, cost of natural gas versus oil, and the cost of electrical energy versus natural gas and oil.

EVALUATIVE METHODS:

Evaluation will be based on a written examination.

BLOCK D: HEATING SYSTEMS

BLOCK D - 1

HEAT TRANSFER

GENERAL OBJECTIVE:

To develop in the trainee an understanding of the basic principles of heat transfer.

PREREQUISITES:

SPECIFIC OBJECTIVES:

The trainee will be able to:

1) describe the three methods of heat transfer:
   a) conduction
   b) connection
   c) radiation
2. describe and explain the operation of:
   a) liquid to liquid system
   b) liquid to air system
   c) air to air system
   d) steam to liquid system
   e) steam to air system
   f) radiant heat system
3. describe the factors affecting heat transfer and efficiency and explain how these factors are effective:
   a) conductivity of different materials
   b) system configuration
   c) maintenance of system.
4. perform basic calculations of system efficiency.

EVALUATIVE METHODS:

Evaluation will be based on a written examination.

BLOCK D - 2 WATER SYSTEMS

GENERAL OBJECTIVE: To develop in the trainee an understanding of the basic principles of hot water heating systems.

PREREQUISITES: D - 1

SPECIFIC OBJECTIVES:

1. The trainee will be able to describe and explain the principles of operation of hot water heating systems,
   a) Hydronic Building Heating System
   b) Domestic hot water heating.
2. The trainee will be able to describe the maintenance and operation of hot water heating systems and the effects on system efficiency and energy economy.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK D - 3 STEAM SYSTEMS

GENERAL OBJECTIVE: To develop in the trainee an understanding of steam systems used for building heating.

PREREQUISITES: D -1

SPECIFIC OBJECTIVES: The trainee will be able to:

1. describe and explain the operation of,
   a) low pressure systems
   b) high pressure systems
   c) one and two pipe systems.
2. Describe and explain the function of,
   a) steam traps
   b) heat exchangers
   c) condensate return
   d) pressure reducing valves.
3. Describe the maintenance and operation of steam heating systems, and the effects on system efficiency and energy economy.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK D - 4 BOILER OPERATION

GENERAL OBJECTIVE: To develop in the trainee an understanding of boiler operation.

PREREQUISITES:

SPECIFIC OBJECTIVES: The trainee will be able to:

1. describe and explain the operation of boilers commonly used in building heating systems
   (a) water and steam boilers
   (b) high and low pressure steam boilers
   (c) type of fuel used
   (d) safety devices
   (e) steam and pressure Plant Act Requirements
2. describe the maintenance and operation of boilers and the effects on efficiency and energy economy.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK D - 5

WATER MANAGEMENT

GENERAL OBJECTIVE: To develop in the trainee a knowledge of the importance of water management, with emphasis on energy consumptio

PREREQUISITES: D-1, D-2, D-3, D-4

SPECIFIC OBJECTIVES: The trainee will be able to describe:

1. the purposes of water treatment
2. the energy savings potential of a clean system
3. why proper test procedures, as set forth by the chemical supplier, should be followed
4. the problems caused by inadequate or random testing of water to be treated
5. the expense of chemical treatment of water, including labor and cost of chemicals
6. the value of keeping complete, legible records on the forms supplied by manufacturers
7. the value of knowing the right contacts at the suppliers' offices, as sources of information and assistance.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK D - 6

AIR HEATING SYSTEMS

GENERAL OBJECTIVE: To develop in the trainee an understanding of air heating systems.

PREREQUISITES:

SPECIFIC OBJECTIVES: The trainee will be able to:

1. describe air heating systems commonly used for building heating, and explain the operation of,
   (a) gas fired furnaces
   (b) steam and hot water coil air systems
   (c) direct fired air heating systems
   (d) Glycol coil air systems
2. describe the maintenance of the above equipment and the effects of good maintenance on efficiency and energy economy.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK D - 7

RADIANT HEATING SYSTEMS

GENERAL OBJECTIVE: To develop in the trainee an understanding of radiant heating systems

PREREQUISITES:

SPECIFIC OBJECTIVES: The trainee will be able to:

1. describe radiant heating systems and their applications, and explain the principles of operation
2. describe the maintenance of radiant heating system and the effects on system efficiency and energy economy.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK E: COOLING SYSTEMS

BLOCK E - 1 PRINCIPLES OF MECHANICAL REFRIGERATION

GENERAL OBJECTIVE: To develop in the trainee an understanding of the basic principles of mechanical refrigeration.

PREREQUISITES:

SPECIFIC OBJECTIVES: The trainee will be able to:

1. describe the basic operation of the refrigeration cycle and explain the function of:
   (a) Compressors
   (b) Condensors
   (c) Evaporators
   (d) Types of refrigerants used
2. describe the basic systems used, in terms of components and operation, of:
   (a) Piston compressor type
   (b) Centrifugal type
   (c) Absorbtion type.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK E - 2

DIRECT EXPANSION SYSTEM

GENERAL OBJECTIVE: To develop in the trainee an understanding of the direct expansion cooling system.

PREREQUISITES: D-1 and E-1

SPECIFIC OBJECTIVES: The trainee will be able to:

1. describe the operation of a direct expansion cooling coil
2. describe the application of direct expansion coils and other related system components

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK E - 3 CHILLED WATER SYSTEMS

GENERAL OBJECTIVE: To develop in the trainee an understanding of chilled water systems.

PREREQUISITES: D-1 and E-1

SPECIFIC OBJECTIVES: The trainee will be able to:

1. describe the operation of a chilled water system
2. describe the application of chilled water systems and related system components.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK E - 4

HEAT PUMPS

GENERAL OBJECTIVE: To develop in the trainee an understanding of the general principles of heat pumps.

PREREQUISITES: D-1 and E-1

SPECIFIC OBJECTIVES: The trainee will be able to:

1. describe the general principle and operation of heat pumps
2. describe the application of heat pumps and their efficiency under different climatic conditions.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK F: VENTILATING SYSTEMS

BLOCK F - 1 AIR CONDITIONING PRINCIPLES AND REQUIREMENTS

GENERAL OBJECTIVE: To develop in the trainee a knowledge of the principles of air conditioning. (Air "conditioning" in its broadest sense, heating, cooling, humidifying, etc)

PREREQUISITES:

SPECIFIC OBJECTIVES: The trainee will be able to describe:

1. the ventilation and air conditioning processes
2. the properties of air, it can be heated, cooled, circulated, compressed, etc
3. the properties of water, it can be heated, cooled, circulated, vaporized, etc
4. the requirements for ventilation and air conditioning, the comfort zone, and effects on people.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK F - 2

BASIC VENTILATION SYSTEM

GENERAL OBJECTIVE: To develop in the trainee a knowledge of the layout of a basic H.V.A.C. system.

PREREQUISITES: F-1

SPECIFIC OBJECTIVES:

A) The trainee will be able to describe the function, and placement of each of the following components in an H.V.A.C. system:

Bird screens, louvres, exhaust, supply and recirculation dampers, fire dampers (different types), air filters, humidifier, baffle or everspray eliminators, heating coil, cooling coil, supply air fan, return air fan, normally closed and open damper positioning, supply diffusers, return air grills, ductwork layout, air flow direction at all damper positions.

B) The trainee will be able to draw a complete H.V.A.C. system on paper depicting all components in their respective positions.

EVALUATIVE METHODS: Evaluation will be based on a written examination which includes the drawing of a H.V.A.C. system.

BLOCK F - 3

AIR FILTERS

GENERAL OBJECTIVE: To develop in the trainee knowledge of the types of filters used in ventilation systems, and skill in checking filter performance.

PREREQUISITES: F-2

SPECIFIC OBJECTIVES:

A) The trainee will be able to describe:

1. the purpose and importance of air filtration
2. the common types of filters and where they are normally used
3. the purpose of pre and after filters and their normal location in a system.

B) The trainee will be able to:

1. read inclined type and dial type manometers
2. use gauge readings and manufacturers' specs to determine when to clean, advance or replace filters
3. check, adjust and maintain inclined and dial type manometers.

EVALUATIVE METHODS: Evaluation of objective A will be based on a written examination. Evaluation of objective B will be based on a practical demonstration of trainee's skills.

BLOCK F - 4 HUMIDIFICATION EQUIPMENT

GENERAL OBJECTIVE: To develop in the trainee knowledge of the purpose, different types, and maintenance of humidification equipment.

PREREQUISITES: F-2

SPECIFIC OBJECTIVES: The trainee will be able to describe:

1. the purpose of humidification and its possible locations in a H.V.A.C. system
2. the principles of operation of the different types as applicable to H.V.A.C. systems
   - float and pan - steam, electric
   - Carnes Lumatic
   - atomizing spray and air wasner spray
   - direct steam
3. the efficiency losses due to poor maintenance

EVALUATIVE METHODS: Evaluation will be based on a written examination.

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BLOCK F - 5

HUMIDITY MEASUREMENT

GENERAL OBJECTIVE: To develop in the trainee knowledge of how to read a Taylor Sling psychrometer (pocket model) and how to read a psychrometric chart in part.

PREREQUISITES: F-2

SPECIFIC OBJECTIVES: The trainee will be able to,

A. define and explain the following:

1. wet and dry bulb temperatures
2. wet and dry bulb thermometers
3. relative humidity
4. dew point

B. use a Taylor sling psychrometer to read humidity:

1. using the Taylor scale
2. using a psychrometric chart

C. use a psychrometric chart and W.B. and D.B. readings to determine dew point

D. describe the possible causes of the appearance of water on walls and windows at different seasons of the year.

EVALUATIVE METHODS: Objectives A and D will be evaluated by means of a written test, evaluation of objectives B and C will be based on a practical demonstration of trainee's skills.

BLOCK F - 6

HEATING - COOLING COILS

GENERAL OBJECTIVE: To develop in the trainee a knowledge of the purpose, and types of heating and cooling coils.

PREREQUISITES: F-2

SPECIFIC OBJECTIVES: The trainee will be able to describe:

A. Heating Coils:
   1. the purpose of a heating coil - to heat and to decrease humidity
   2. the types - steam and hydronic, preheat and reheat
   3. the location of heating coils in an H.V.A.C. system.

B. Cooling Coils:
   1. the purpose to lower temperature and to de-humicify
   2. the types, chilled water and direct expansion
   3. location of cooling coils in an H.V.A.C. system

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK F - 7

AIR DAMPERS

GENERAL OBJECTIVE: To develop in the trainee knowledge and skill in the adjustment procedures pertinent to exhaust, supply and recirculation dampers.

PREREQUISITES: F-2

SPECIFIC OBJECTIVES: The trainee will be able to:

1. describe the purpose of dampers (to regulate air flow and volume).
2. explain why adjustment is very important (ie: a substantial reduction in energy costs)
3. describe and use recommended limits for conditioned spaces
4. adjust the different types of damper, linkage mechanisms, opposed blade, air foil, etc., for maximum energy savings.

EVALUATIVE METHODS: Evaluation of objectives 1, 2 and 3 will be based on a written examination, evaluation of objective 4 will be based on a practical demonstration of trainee's skill.

BLOCK G: CONTROL SYSTEMS

BLOCK G - 1

INTRODUCTION

GENERAL OBJECTIVE: To develop in the trainee a knowledge of the philosophy and basic principles of control systems, their significance in H.V.A.C. systems and their vital importance in energy use and conservation.

PREREQUISITES: Nil

SPECIFIC OBJECTIVES: The trainee will be able to:

A. describe the general nature of a control system and the function of each component in the system

B. explain how control systems can affect the efficiency of energy use

C. define the following fundamental terms:

1. set point
2. control point
3. deviation
4. offset
5. corrective action
6. cycling
7. lag

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK G - 2

MEASUREMENTS

GENERAL OBJECTIVE: To develop in the trainee knowledge of measuring devices used in control systems and how they work.

PREREQUISITES: G-1

SPECIFIC OBJECTIVES: The trainee will be able to describe the principles of operation and the parameters measured by each of:

1. Bi-metal actuators
2. Rod and Tube actuators
3. Sealed bellows elements - gas, liquid, refrigerant filled
4. Remote bulb
5. Diaphram
6. Resistance elements
7. Thermistor
8. Thermocouple
9. Humidity elements
10. Bourdon tube
11. Float control

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK G - 3 PNEUMATIC CONTROLS - AIR SUPPLY

GENERAL OBJECTIVE: To develop in the trainee knowledge of the need for clean, regulated air supply, and skill in checking and adjusting the operation of a compressed air supply.

PREREQUISITES: G-2

SPECIFIC OBJECTIVES: The trainee will be able to explain the purpose and importance of clean regulated air supply, and will be able to check and maintain air compressors to the extent required for pneumatic controls comprised of:

1. Compressor Operation
2. Safety relief valve
3. Pressure differential switch
   a) C.F.M. ratings
   b) Cycling times
4. Condensed water blow off valves
5. Air filter maintenance
6. Oil changes
7. Air leaks
8. Air gauges
9. Automatic water ejectors and proper maintenance installation methods and different types
10. Oil separators/maintenance
11. Belt - measurement, alignment, tension settings, amprobe readings
12. Pressure regulating valves

EVALUATIVE METHODS:

Evaluation of objectives 2 and 11 will be based on a practical demonstration of trainee's skills; all other objectives will be evaluated by a written examination.

BLOCK G - 4 PNEUMATIC CONTROLS - COMPONENTS

GENERAL OBJECTIVE: To develop in the trainee a knowledge of the components of pneumatic control systems, and skill in the calibration of such components.

PREREQUISITES: G-3

SPECIFIC OBJECTIES: The trainee will be able to,

A. describe the principles of operation,

B. identify location in a control system, and

C. perform basic calibration of :

1. Room thermostats - direct and reverse action, single and double temperature
2. damper motors - single and two stage
3. positive positioning relays
4. pressure electric switches
5. solenoid air valves
6. 3 - way valves - mixing and diverting
7. globe valves - normally closed and normally open
8. static pressure controllers
9. minimum positioning controls
10. freeze protection devices
11. fire air stats
12. averaging relays
13. submaster controls (simple) and direct action proportional reverse re-adjustment
14. master controls - compensated type
15. airline restrictors
16. gradual relays
17. direct and reverse acting relays
18. day-night thermostats
19. averaging relays, selector relays
20. humidity controllers - duct and room type
21. summer-winter controls
22. single and dual input sensor controllers
23. rod and tube insertion temperature controller
24. high limit controls
25. snap acting relays
26. summer-winter thermostats
27. radiator valves
28. transducers

Block G - 4 - cont'd

EVALUATIVE METHODS: Evaluation of objectives A and B will be by means of a written examination. Objective C will be evaluated by a practical demonstration of the trainee's skill.

BLOCK G - 5 SCHEMATIC READING - MIXED AIR CONTROL SYSTEMS

GENERAL OBJECTIVE: To develop in the trainee the ability to sketch and hence to read and interpret, control schematics of single zone mixed air systems.

PREREQUISITES: G-4

SPECIFIC OBJECTIVES: The trainee will be able to:

A. draw a complete schematic diagram of a manual single zone mixed air control system

B. describe how the system, as drawn, works

C. draw a complete schematic diagram of an automatic single zone mixed air control system with manual operation capability

D. describe how the system, as drawn, works.

EVALUATIVE METHODS: Evaluation will be based on a written examination which will include the necessary drawing component.

BLOCK G - 6

SCHEMATIC READING - HUMIDIFICATION SYSTEMS

GENERAL OBJECTIVE: To develop in the trainee the ability to sketch and hence to read and interpret, control schematics of automatic humidification systems.

PREREQUISITES: G-4

SPECIFIC OBJECTIVES: The trainee will be able to:

A. draw a complete schematic diagram of an automatic humidification system

B. describe how the system, as drawn, works.

EVALUATIVE METHODS: Evaluation will be based on a written examination which will include the necessary drawing component.

BLOCK G -7 SCHEMATIC READING - SAFETY CONTROLS

GENERAL OBJECTIVE: To develop in the trainee the ability to sketch and hence to read and interpret, control schematics of safety controls in single zone systems.

PREREQUISITES: G-4

SPECIFIC OBJECTIVES: The trainee will be able to:

A. draw a schematic diagram of a single zone system with master, and submaster control of heating and cooling coils

B. draw a schematic diagram of the safety controls in a single zone system; fire, freeze and high temperature controls

C. describe how the systems, as drawn, work.

EVALUATIVE METHODS: Evaluation will be based on a written examination which will include the necessary drawing component.

BLOCK G - 8

SCHEMATIC READING - TOTAL SINGLE ZONE SYSTEMS

GENERAL OBJECTIVE: To review and reinforce the trainee's skills in sketching and reading control schematics for a complete single zone mixed air system.

PREREQUISITES: G-5, G-6, G-7

SPECIFIC OBJECTIVES: The trainee will be able to draw a schematic diagram of a complete single zone mixed air system, with all control components. The trainee will be able to describe the operation of all parts of the system and the function of each component.

EVALUATIVE METHODS: Evaluation will be based on a written examination which will include the necessary drawing component.

BLOCK G - 9

SCHEMATIC READING - MULTIZONE SYSTEMS

GENERAL OBJECTIVE: To develop in the trainee the ability to sketch and hence to read and interpret, control schematics of multizone systems.

PREREQUISITES: G-8

SPECIFIC OBJECTIVES: The trainee will be able to:

1. draw a complete multizone (2 zone) control system, with all control components
2. describe the operation of all parts of the system.

EVALUATIVE METHODS: Evaluation will be by means of a written examination which will include the necessary drawing component.

BLOCK G - 10 SCHEMATIC READING - INDUCTION UNITS

GENERAL OBJECTIVE: To develop in the trainee the ability to draw and hence to read and interpret, control schematics for a primary air system with induction units and reheats.

PREREQUISITIES: G-4

SPECIFIC OBJECTIVES: The trainee will be able to:

1. describe the principles of operation and the functional purpose of induction units
2. draw a schematic diagram of a primary air system complete with induction units and terminal reheats
3. describe the operation of the system as drawn.

EVALUATIVE METHODS: Evaluation will be based on a written examination which will include the necessary drawing component.

BLOCK G - 11 SCHEMATIC READING - VARIABLE AIR VOLUME SYSTEM

GENERAL OBJECTIVE: To develop in the trainee the ability to sketch and hence to read and interpret, control schematics for a variable air volume (V.A.V.) system.

PREREQUISITES: G-4

SPECIFIC OBJECTIVES: The trainee will be able to:

1. draw a schematic diagram of a variable air volume system
2. describe the operation of the system as drawn.

EVALUATIVE METHODS: Evaluation will be based on a written examination which will include the necessary drawing component.

BLOCK G - 12

SCHEMATIC READING - MANUFACTURERS' SCHEMATICS

GENERAL OBJECTIVE: To develop in the trainee the ability to read and interpret standard schematics as published by the major control manufactureres.

PREREQUISITES: G-8, G-9, G-10, G-11

SPECIFIC OBJECTIVES: The trainee will be able to read and interpret schematic diagrams published by Johnson, Honeywell and M.C.C Powers control companies.
The trainee will be able to describe the operation of control systems from the schematics provided by any of the companies.

EVALUATIVE METHODS: Evaluation will be based on the use of schematic diagrams provided by all three of the control companies referred to in the objectives.

BLOCK H: ELECTRICITY

BLOCK H - 1

BASIC THEORY

GENERAL OBJECTIVE: To develop in the trainee, the ability to use and understand Basic Electrical Theory as applied to energy conservation.

PREREQUISITES: A-6

SPECIFIC OBJECTIVES: The trainee will be able to:

1. apply Ohm's Law to determine voltage, current or resistance in a simple series circuit
2. apply the appropriate formulae to determine power in a single or three phase circuit
3. apply the appropriate formulae to determine power factor in a single or three phase circuit.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK H - 2

DIRECT AND ALTERNATING CURRENT

GENERAL OBJECTIVE:

To develop in the trainee a knowledge of the differences between, and the applications of, DC and AC.

PREREQUISITES:

SPECIFIC OBJECTIVES:

The trainee will be able to:

1. describe the difference between DC and AC,
2. describe the purposes of and principles of operation of,
   a) full wave and half wave rectifiers
   b) battery banks for standby power
   c) invertors for standby power.
3. describe the effect on power factor of the reactances in RL, RC and RLC circuits,
4. describe sine waves and phase angles.

EVALUATIVE METHODS:

Evaluation will be based on a written examination.

BLOCK H - 3

ELECTRICAL MEASUREMENTS

GENERAL OBJECTIVE:

To develop in the trainee, skill in the reading and recording of various electrical measurements.

PREREQUISITES:

A -2

SPECIFIC OBJECTIVES:

The trainee will be able to read the appropriate meters and record correctly and with justifiable accuracy:

1) Voltage
2) Current
3) Resistance
4) Power
5) Energy
6) Power factor.

EVALUATIVE METHODS:

Evaluation will be based on a practical demonstration of the trainee's skill.

BLOCK H-4 TRANSFORMERS

GENERAL OBJECTIVE: To develop in the trainee an understanding of AC voltage and current transformation.

PREREQUISITES: A - 6

SPECIFIC OBJECTIVES: The trainee will be able to:

- describe operation of a simple transformer
- explain voltage/current ratios in transformers
- explain KVA ratings of transformers.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK H - 5

ELECTRIC MOTORS AND CONTROLS

GENERAL OBJECTIVE:

To develop in the trainee an understanding of electric motor operation including nameplate data.

PREREQUISITES:

SPECIFIC OBJECTIVES:

The trainee will be able to describe:

1) the operation of single and three phase motors, their types and application,
2) synchonous motor operation,
3) nameplate data including power factor and effect on system demand,
4) various starting methods for single phase and three phase motors.

EVALUATIVE METHODS:

Evaluation of objectives 1,2 and 4 will be based on a written examination, evaluation of objective 3 will be based on actual reading and interpretation of nameplate data.

BLOCK I: ENERGY CONSUMPTION

BLOCK I - 1 READING METERS

GENERAL OBJECTIVE: To develop in the trainee skills in the reading of meters such as; electric, gas, natural gas, oil, water, propane, condensate.

PREREQUISITES: A -2

SPECIFIC OBJECTIVES: The trainee will be able to:

1. read all types of meters,
2. determine the consumption indicated by electric meter readings,
3. determine the demand indicated by electric meter readings,
4. calculate the consumption and demand using the correct multiplier,
5. read the energy consumption of all fuels, be it an analog or a digital meter.

EVALUATIVE METHODS: Evaluation will be based on a practical demonstration of the trainee's skills.

BLOCK I -2 RECORDS KEEPING

GENERAL OBJECTIVE: To develop in the trainee the skill which will enable him to maintain records of all energy consumed.

PREREQUISITES: A -3, A-4, A-5.

SPECIFIC OBJECTIVES:

1. The trainee will be able to perform all necessary calculations to convert all energy consumed into standard SI units, which for buildings will be megajoules per meter squared per annum.
2. For a building requiring a monitoring or a graph, the trainee will be able to graph the megajoules per meter squared per month versus the month on a standard graph.

EVALUATIVE METHODS: The objectives will be evaluated by means of a written examination or by instructor observation.

BLOCK I -3 UNITS AND STANDARDS

GENERAL OBJECTIVE: To develop in the trainee a familiarity with units of energy and with standards established by various authorities.

PREREQUISITES: A - 4

SPECIFIC OBJECTIVES:

1. The trainee will be able to convert energy and power units into the corresponding SI units and perform calculations with these units.
2. The trainee will be able to identify standards established by such authorities as ASHRAE and IES which apply to the facility for which he/she is responsible.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK I -4 DEMAND ECONOMICS

GENERAL OBJECTIVE: To develop in the trainee an understanding of the importance of demand and costs of demand for electrical energy.

PREREQUISITES: A -3 and I - 1.

SPECIFIC OBJECTIVES:

1. The trainee will be able to perform the necessary calculations to show the importance of demand control.
2. The trainee will be able to describe the importance of demand control through the use of demand limiting and cycling devices such as parking lot control, domestic water heating control, fan systems control, etc..

EVALUATIVE METHODS: Objective 1 will be evaluated by means of a written examination.
The evaluation of objective 2 will be based on observation of the instructor as well as requesting a project, complete with calculations showing the advantage of load shed; for example, calculate the cost savings if 1,000 cars were placed on a load shed control.

BLOCK J: MAINTENANCE

BLOCK J - 1 SYSTEMS EFFICIENCY

GENERAL OBJECTIVE: To develop in the trainee an understanding of the requirement for an efficient operating system.

PREREQUISITES:

SPECIFIC OBJECTIVES: The trainee will be able to describe areas where energy conservation can be most effective:

1. Lighting
2. Heating and ventilating
3. Windows, doors and insulation
4. General Maintenance.

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK J - 2

JANITORIAL ORGANIZATION

GENERAL OBJECTIVE: To develop in the trainee an awareness of janitorial problems pertaining to energy conservation.

PREREQUISITES:

SPECIFIC OBJECTIVES: The trainee will be able to describe and explain the need for:

1. attaining desired humidity and temperature control
2. regular cleaning of all return air vents and anemostats
3. regular checks on air filters and humidifier conditions
4. general cleanliness of buildings floors, windows, high dusting
5. the importance of adhering to maintenance schedules

EVALUATIVE METHODS: Evaluation will be based on a written examination.

BLOCK J - 3

LIGHT FIXTURES

GENERAL OBJECTIVE:

To develop in the trainee an awareness of the importance of maintaining light fixtures at peak efficiency.

PREREQUISITES:

SPECIFIC OBJECTIVES:

The trainee will be able to explain the need to:

1. ensure light fixtures are cleaned regularly
2. replace faulty lamps and or ballasts as required
3. ensure lights are turned off or down whenever possible
4. break even point with fluorescent lamps.

EVALUATIVE METHODS:

Evaluation will be based on a written examination.

BLOCK 3 - 7

STEAM TRAPS

GENERAL OBJECTIVE:

To develop in the trainee knowledge of the importance of proper servicing of steam traps, and skill in checking the performance of steam traps.

PREREQUISITES:

D-1, D-3, D-4, D-5.

SPECIFIC OBJECTIVES:

A. The trainee will be able to describe the principles of operation of:

1. a float and thermostat trap
2. an inverted bucket and lift trap
3. a steam disc. trap

B. The trainee will be able to:

1. check the operation of traps using a pocket probe pyrometer and/or any other recognized method
2. explain and discuss the energy costs of a leaking steam trap.

EVALUATIVE METHODS:

Evaluation of objective A and B-2 will be based on a written examination.

Evaluation of objective B-1 will be based on a practic. demonstration of trainee's skills.

Appendix B

PILOT COURSE

OUTLINES

B.1 COURSE OUTLINE FOR ENERGY MANAGEMENT PILOT PROGRAMME.

Term 1

Week 1.
Day 1. 2 Hours.

Topic: Introduction to Building Services

An illustrated introduction to the course content its aims and objectives

The presentation includes -

The function of the building enclosure

Environmental comfort

Day 2. 3 Hours.

Topic: Relationships of the interplay of interior and exterior conditions and the building envelope.

Climate oriented - Solar effects
Temperature differentials
Vapour pressure differences
Air pressure differences
Wind flow

Occupancy oriented - Mechanical systems
- Comfort requirements of occupants

Week 2.
Day 1. 2 Hours.

Topic: Basic Units and Principles.

Review of basic units of measurement used in HVAC, terminology and abbreviations, heat and change of state.

Day 2. 3 Hours.

Topic: Relationship of Temperature, Pressure and Volume.

Review of Boyles Law, Charles Law, General Gas Law and Pascal's Law of Partial Pressures.

Week 3.
Day 1. 2 Hours.

Topic: Relationship Between Pressure of Air and Pressure of Water Vapour in the Atmosphere.

Application of psychrometric tables.

Day 2. 3 Hours.

Topic: Relationship between Specific Humidity, Relative Humidity, Specific Volume, Dew Point Temperature, Dry Bulb and Wet Bulb Temperatures, Sensible Heat, Latent Heat and Enthalpy.

Application of the Sling Psychrometer.

Development and uses of the pshychrometric chart.

Week 4.
Day 1. 2 Hours.

Topic: Air Handling Systems

Single zone air handling systems
Multizone air handling systems
Dual duct air handling systems

Study of heating air with and without humidification using a single zone system utilizing the psychrometric chart, the basic heat equation and latent heat of evaporation tables.

Day 2. 3 Hours.

Field Trip to Multi-Story Office Structure, Air Handling Systems.

Building staff, through the use of working drawings of structure, describe building systems.

Tour of building services.

Discussion period relevant to systems and building toured.

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Week 5.
Day 1. 2 Hours.

Topic: Water and Steam Heating Systems

One pipe systems
Two pipe systems
Boiler types
Heat exchangers - Baseboard, induction, coils, etc.

Day 2. 3 Hours.

Field Trip to Multi-Story Complex Utilizing Central Steam Heating System.

Same format as Week 4, Day 2.

Week 6.
Day 1. 2 Hours.

Topic: Refrigeration Principles

Compression refrigeration cycle
Application of DX systems
Application of psychrometric chart to cooling problems.

Day 2. 3 Hours.

Field Trip Same Format as Week 4, Day 2.

Week 7.
Day 1. 2 Hours.

Topic: Practical Studies of Cooling Processes on Psychrometric Chart

Overview of types and functions of condensers, evaporators, chilled water equipment.

Changes to air/water vapour mixtures as mixture flows through components.

Apparatus dew point.

Bypass factors.

Day 2. 3 Hours.

Topic: Field Trip Same Format as Week 4, Day 2.

Week 8.
Day 1. 2 Hours.

Topic: Boiler Operation

Day 2. 3 Hours.

Topic: Filters, Types, their Operations and an Overview of their Function and Maintenance.

Dampers, Diffusers, Conditioned Space Air Mixing, Fan-Coil Units and Similar Space Conditioning Equipment.

Week 9.
Day 1. 2 Hours.

Field Trip to Delta 10000 Computer Installation.

Day 2. 3 Hours.

Topic: Heat Loss and Heat Gain Factors.

Sources of heat loss
Sources of heat gain
Effects of solar radiation on heat gain loads
Thermal gradient probabilty graphs
Relationship of air and water vapour movement through building envelope to heat flow and loads
Condensation and ventilation considerations

Week 10.
Day 1. 2 Hours.

Topic: Overview of Heat Pump Systems and Energy Recovery Methods.

Day 2. 3 Hours.

Overview of programme, general test on objectives and discussion by students on course content - its weaknesses and strengths.

B.2 MODIFIED UNITS OF INSTRUCTION.

Term 2

The operation and maintenance of building Heating and Air Conditioning systems.

Week 1.

6 Hours.

Basic design of low pressure heating boilers,

Parts, fittings, combustion, and boiler firing for energy conservation.

Week 2.

6 Hours.

Automatic boiler controls, water treatment, operation and maintenance for energy conservation.

Week 3.

6 Hours.

Hydronic heating, warm air, infra-red, and electric heating; ventilation and humidification systems operation.

Week 4.

6 Hours.

Heating system controls, basic electricity and electrical power conservation methods.

Week 5.

6 Hours.

Basic principles of refrigeration and refrigeration equipment.

Week 6.

6 Hours.

Refrigeration controls and accessories operation; maintenance of refrigeration systems and energy conservation tips.

Week 7.

6 Hours.

Basic principles of air conditioning and air conditioning equipment.

Air conditioning systems, air conditioning control systems, system opeation and maintenance.

Week 9.

6 Hours.

Tour of RRCC Heating and Air Conditioning systems.

Week 10.

6 Hours.

Tour of St. Vital School Division
Energy Conservation Projects,
Including incinerator, heat recovery system, ventilation system, electrical systems, and construction methods.

APPENDIX C

PUBLIC COURSE

OUTLINE

RED RIVER COMMUNITY COLLEGE

ENERGY MANAGEMENT FOR BUILDING OPERATORS

Course Description

The course was taught one day a week, four hours a day, for a period of 20 weeks, providing for a total of 80 hours of instruction.

The outline and recommended scheduling was as follows:

TIME		UNITS OF INSTRUCTION
	I	Building Operative Review
Weeks 1 and 2 (8 hours)		- low pressure heating - fire tube, water tube, cast iron section construction - operation of boiler fittings and controls - principles of combustion - operation of combustion safety equipment - boiler water treatment
	II	Heating Systems
		Operation of low pressure heating systems
Weeks 3 and 4 (8 hours)		- difference between hydrant and steam heating system - warm air heating system design and operation - operation of infrared heating system - methods of electric heating - heating and passive solar heat - proper ventilation - common ventilating systems - humidification - relative humidity - construction and operation of building humidification equipment - operation of heating system controls.

III **Building Electrical Systems**

Basic electrical theory in the areas of

Week 5
(4 hours)

- lighting theory
- building electrical distribution equipment
- operations of electrical meters
- reading different types of electrical meters

IV **Refrigeration Theory**

Week 6
(4 hours)

- the mechanical refrigeration cycle
- absorption refrigeration equipment
- operation and maintenance of refrigeration equipment
- operation of refrigeration system controls

V **Air Conditioning Theory and Equipment**

Understanding the need for air conditioning in large buildings:

Week 7
(4 hours)

- basic air conditioning theory
- use of the psychometric chart
- comfort chart and how it can be used in building operation
- air conditioning equipment
- air conditioning control systems operation

VI **Energy Conservation Theory**

Weeks
8 and 9
(8 hours)

- define energy conservation
- designing an energy conservation program
- surveying energy uses and losses
- implementing energy conservation actions
- understanding elements of an energy audit
- developing energy conservation charts for student's building
- defining a degree day
- relating degree days to fuel conservation
- fuel calculation based on degree days

VII **Building Design for Energy Conservation**

Understanding how building heating and cooling loads are influenced by heat transfer through building envelope:

Weeks
10 to 12
(12 hours)

- infiltration
- internal heat gain
- basic building construction methods
- energy efficient construction methods
- comparison of insulation types and methods of installation
- how HVAC system modification and maintenance effect energy use
- purposes of lighting
- methods of improving lighting efficiency
- methods of electrical power conservation

VIII **Energy Conservation through Combustion Control**

Weeks
13 to 16
(16 hours)

- methods of calculating combustion efficiency
- methods of obtaining high combustion efficiency from fuel burning appliances
- methods of using waste materials as fuels
- heat loss analysis
- methods of increasing heat transfer

IX **Energy Conservation by Retrofitting Existing Equipment**

Weeks
17 to 20
(16 hours)

- operation of electronic fuel ignition systems
- principle of vent dampers
- methods of heat recovery
  - by recuperators
  - heat wheels
  - incinerator heat recovery
  - heat pump theory of operation
  - operation of air to air and ground water heat pump systems
- operation and application of active solar heating systems
- operation and application of passive solar heat systems
- operation of slush pond cooling systems
- principles of operation and applications of microcomputer based energy management systems

20 Weeks
80 Hours

APPENDIX D

TRAINING PANELS

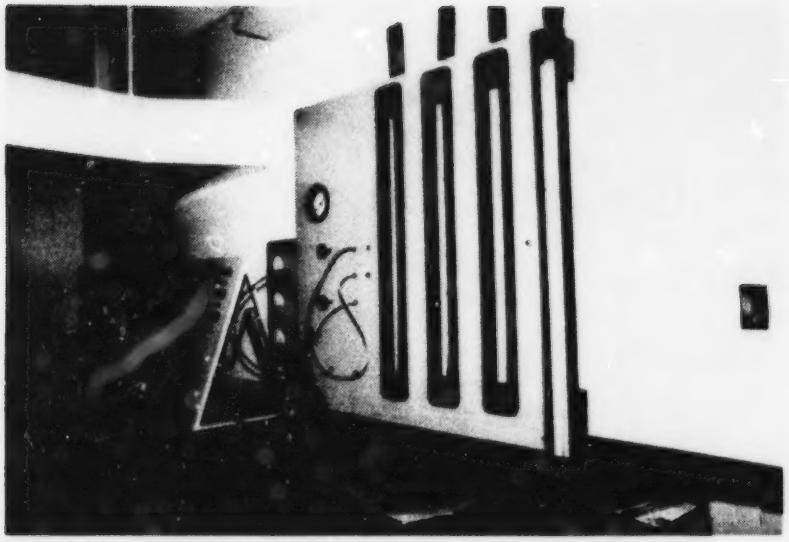

Figure 1. Meter Panels, with typical controls for training.

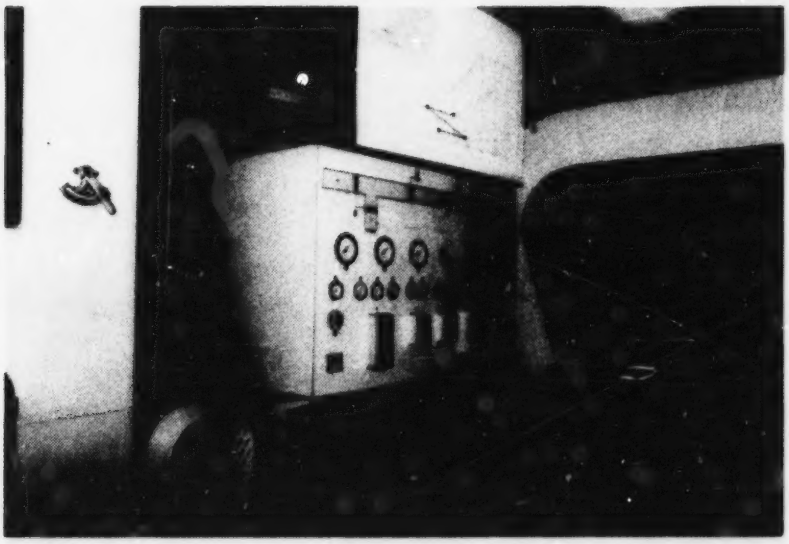

Figure 2. Air handling equipment, for demonstrating variable air volume systems.

POOR

QUALITY

ORIGINAL